Isomer studies @ CARIBU using CPT near ^{132}Sn

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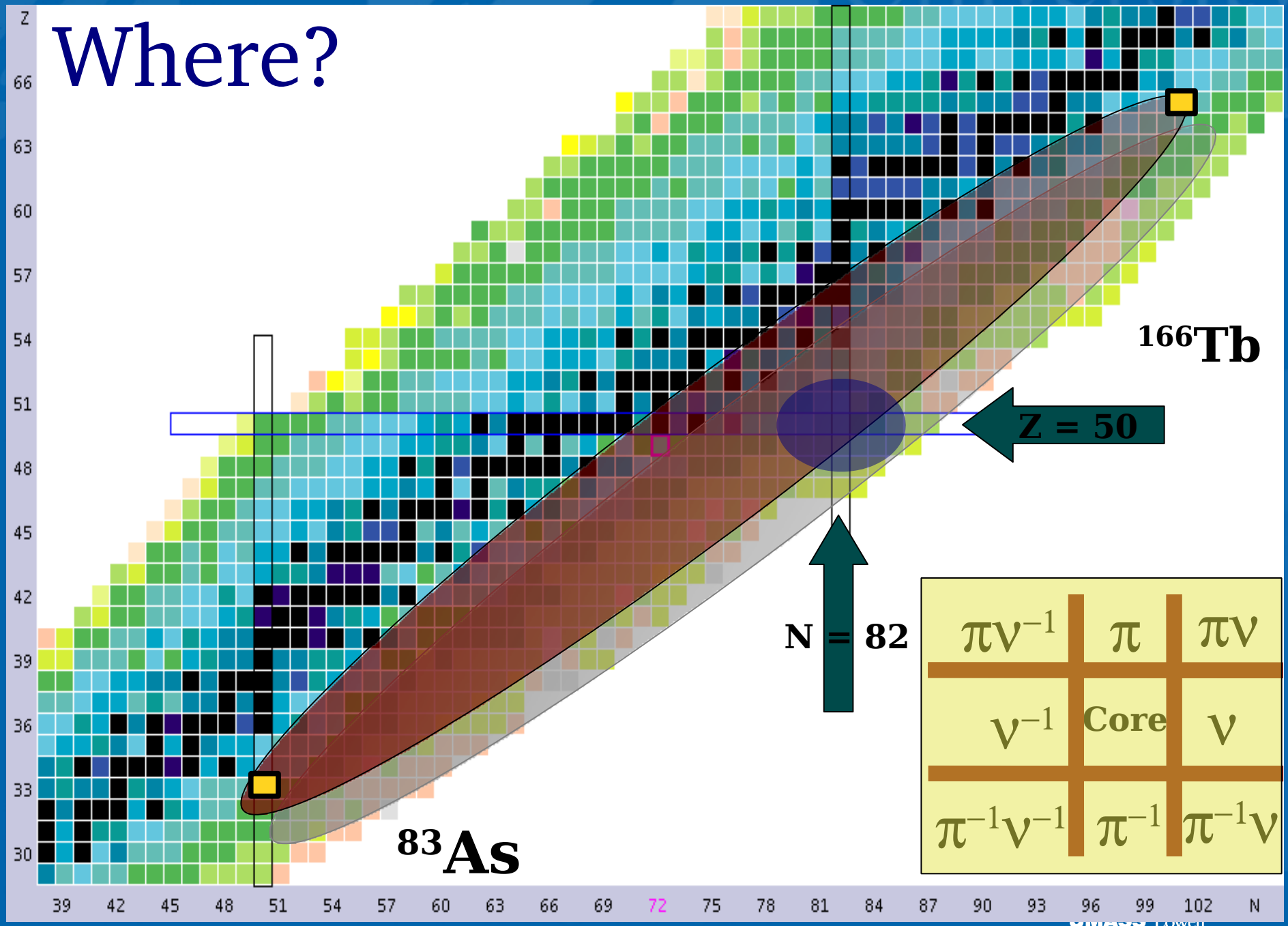
Where?

Why?

How?

Where?


Z
66
63
60
57
54
51
48
45
42
39
36
33
30
39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99 102 N
166Tb
Z = 50
N = 82
83As
πν−1 π πν
ν−1 Core ν
π−1ν−1 π−1 π−1ν

Why?

- Not much is known on neutron – rich side of the beta – stability valley e.g. first excited state, half-lives etc.
- Direct information on single – particle energies
- To fix level energies of known isomers
- To understand isomeric yield
- Provide crucial input to shell models

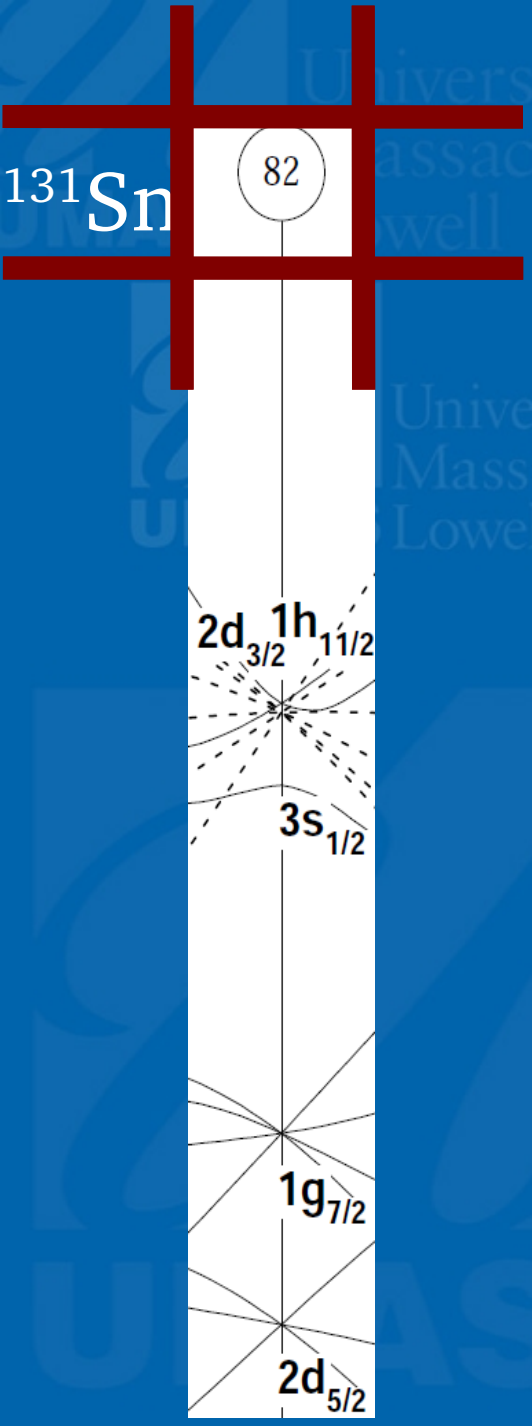
Why with CARIBU and CPT?

- ^{252}Cf fission will provide neutron – rich isotopes near ^{132}Sn with sufficient intensity (10^6 ions/sec).

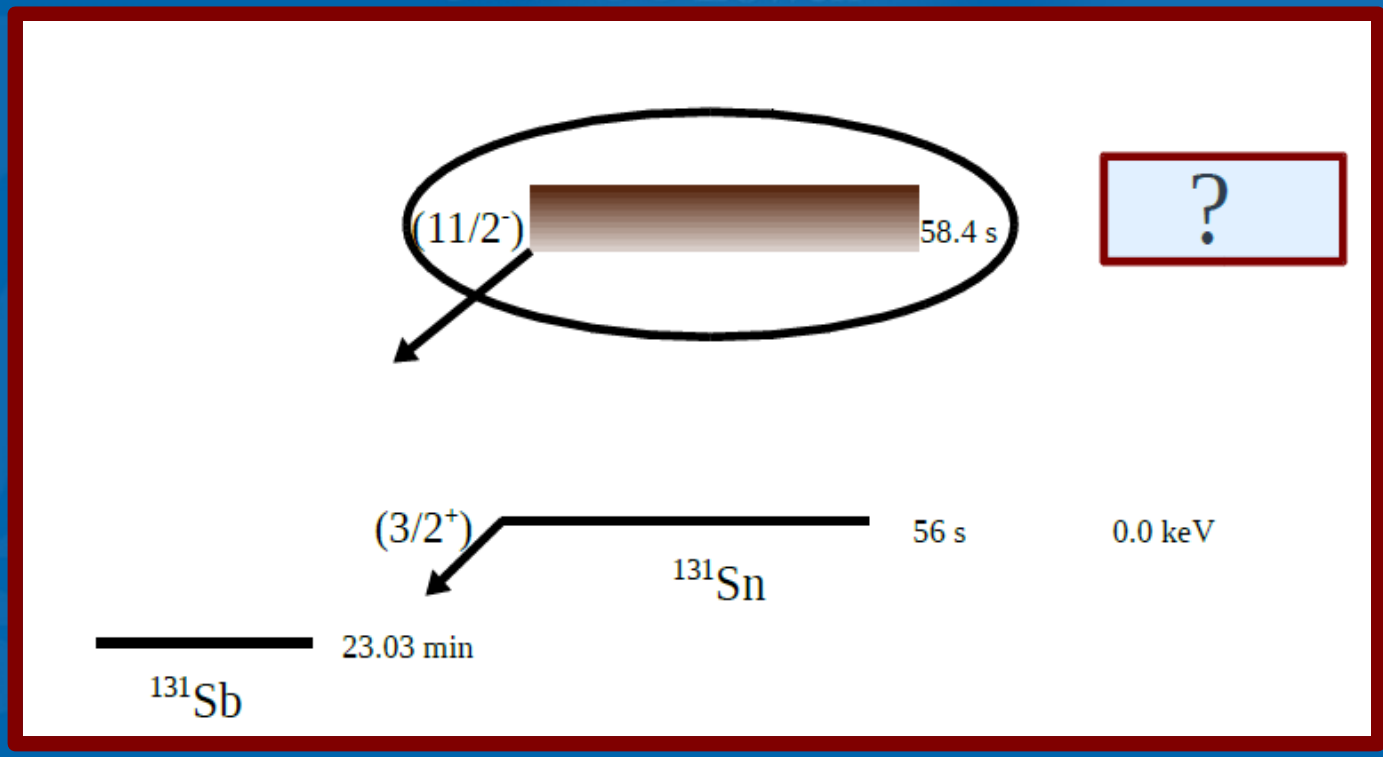
- The isomer half – lives are long enough (seconds to minutes) so that they can be extracted from the ion – source.

- Expected energy separation between the ground state and the isomeric state is large enough to separate them using the CPT.

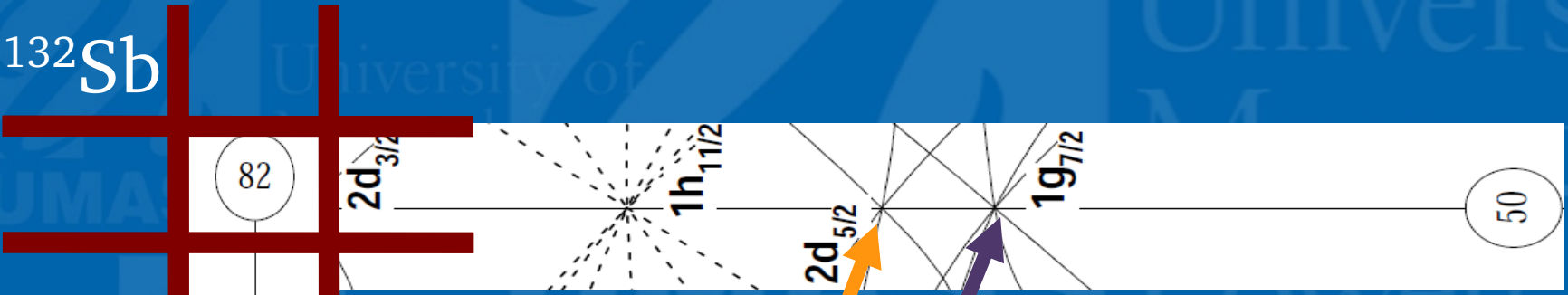
- Ground state masses of all the isotopes of interest are known very precisely.

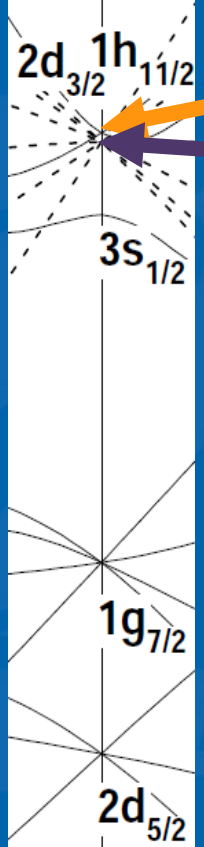


- Neutron hole in N = 82
- Yield: 8x10^5 ions/sec
- Weisskopf estimates suggest $E_{11/2^-}$ = 700 -900 keV; in agreement with N = 81 syst.
- Experimental studies expect this value to be around 65 keV --- in accordance with Odd-A Sn isotopes.



^{132}Sb

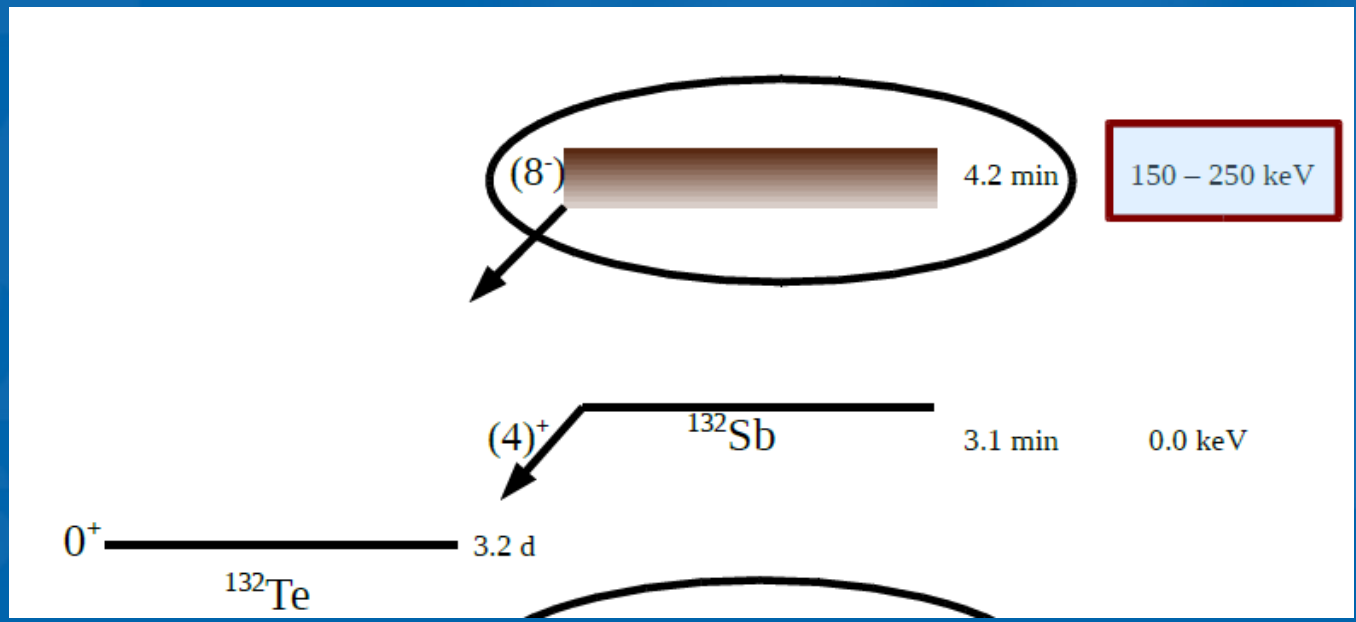


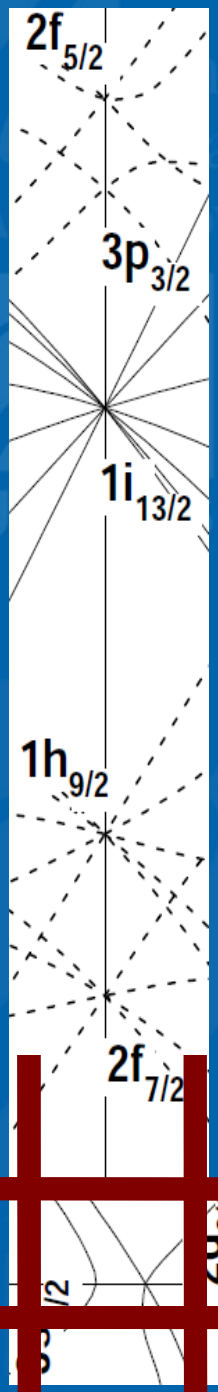


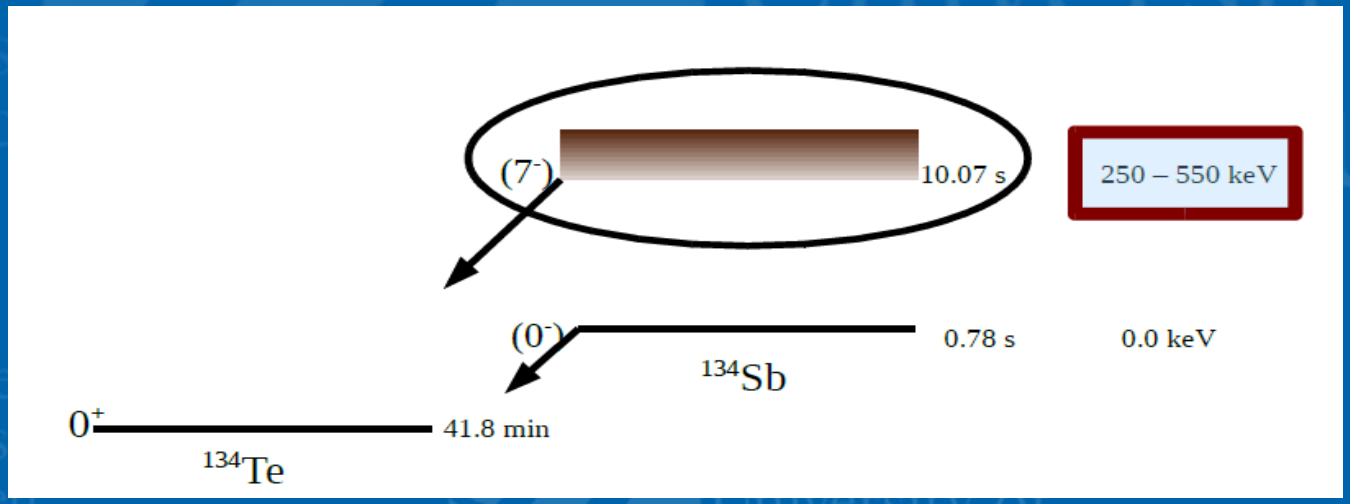
4+

8-

- Yield: 1.9x10^{6} ions/sec
- Ordering of both the isomers is not well established.
- 8^{-} is expected less 200 keV above 4^{+}.

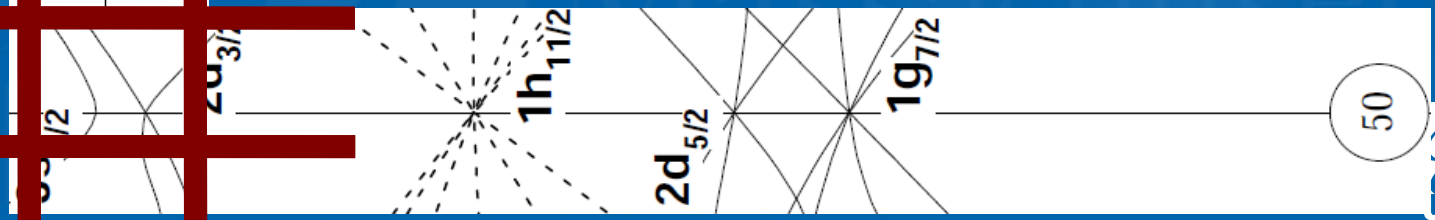






- Yield: 1.5x01^{6} ions/sec
- Ordering of 0^{-} and 7^{-} is not known experimentally
- Shell model predicts 7^{-} to lie between 250-550 keV above 0^{-} state.

^{134}Sb



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How?

- No gamma rays originate from the isomeric states.
- All the isomers decay with 100% beta decay branch to their daughter nuclei.
- Two approaches to determine the excitation of such isomers

(1.) Beta – Gamma coincidence:
Limitations: Beta and gamma efficiencies, large errors (few tens of keV), background..

(2.) Mass measurements:
Limitations: Half lives and mass resolution

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Resolution of nuclear ground and isomeric states by a Penning trap mass spectrometer

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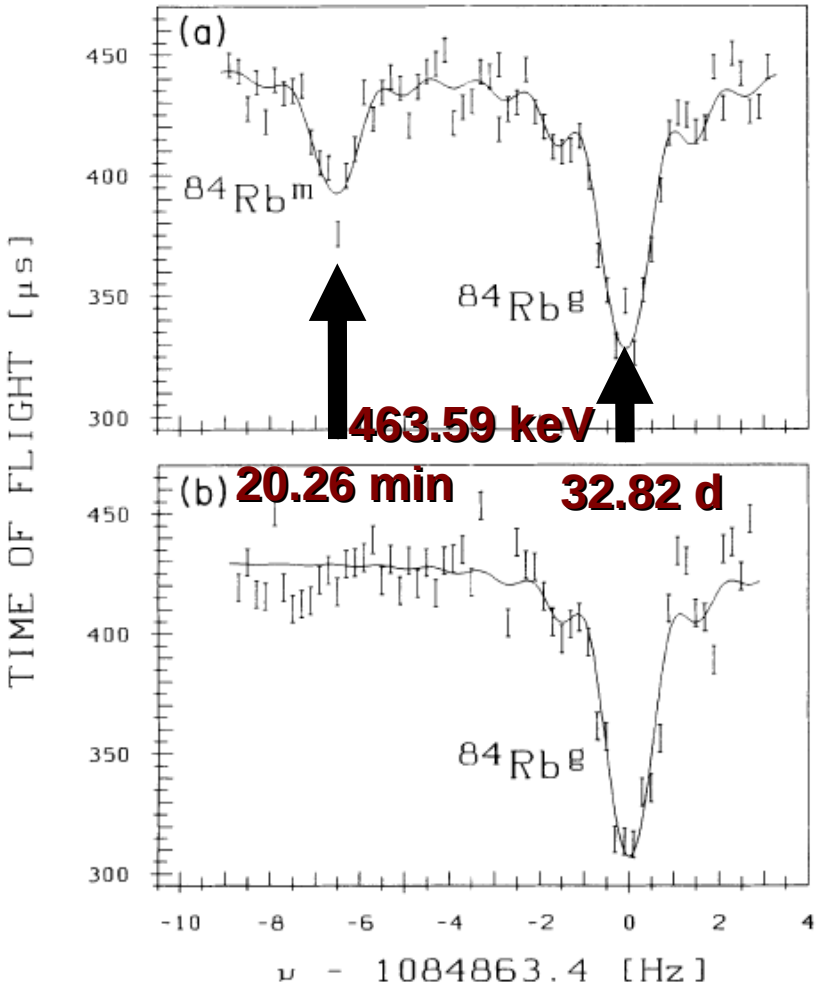

FIG. 1. Cyclotron resonances for ^{84}Rb ions. The measurements were performed (a) shortly after the collection of the ions and (b) with a delay of several half-lives of the isomeric state.

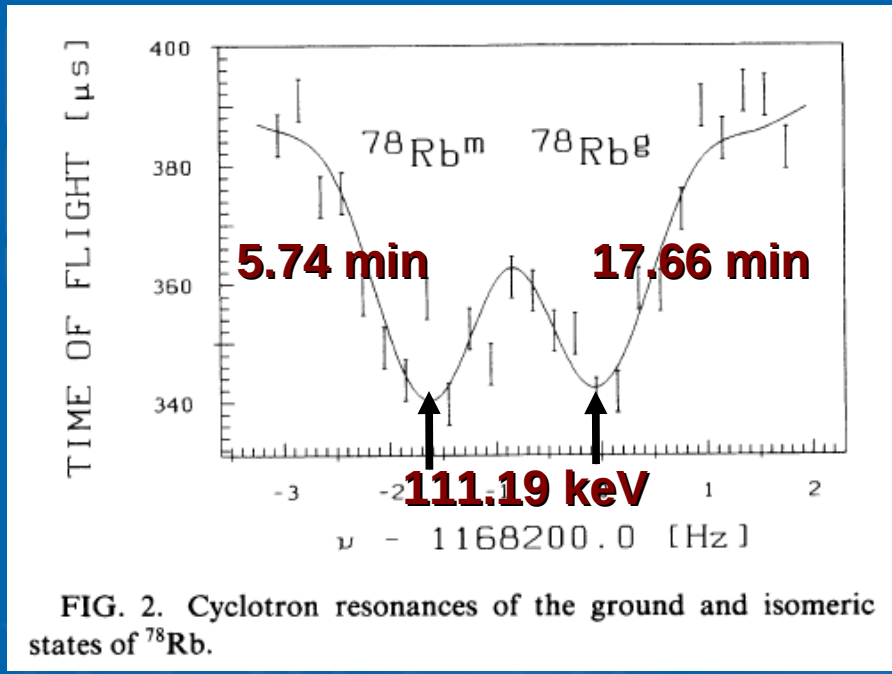

FIG. 2. Cyclotron resonances of the ground and isomeric states of ^{78}Rb.

Well known isomers in 130In, 133Te, 134I, 135Xe, 136I etc. could be used for calibration and/or to check feasibility of the technique.

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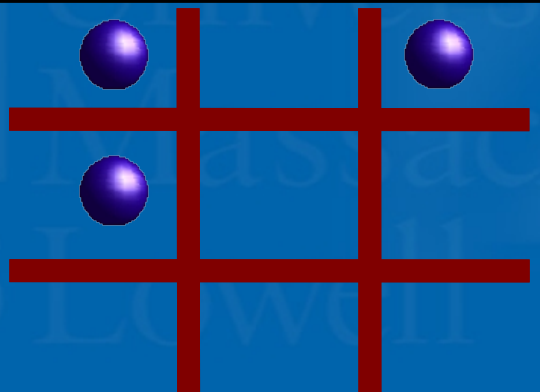
Alternatively,

The beta – gamma coincidence studies at decay station can also be performed to estimate the excitation energies of the isomers.

The two measurements will complement each other.

Summary

- Possible candidates for isomeric studies using CPT near neutron – rich doubly magic ^{132}Sn are discussed.
- Isotopic yields are of the order of 10^6 ions/sec.
- Half lives are long enough to extract ions from the ion source.
- Expected energy difference between the ground states and the isomeric states is well above mass resolution of the CPT.
- These measurements will provide a test of shell model calculations on neutron-rich side of nuclear chart.
- These measurements require expertise from the CPT group.



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Thank you

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